Effects of *Pseudomyrmex spinicola* and *Crematogaster sp.* on Nearest Neighbor Occupancy of *Acacia collinsii*

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Abstract: The ant species *Pseudomyrmex spinicola* and *Crematogaster sp.* are found in a mutualistic relationship with *Acacia collinsii* in the dry forest of Palo Verde National Park, Costa Rica. We hypothesized that the ant species occupying the largest *A. collinsii* tree in a stand influences the colonization of its nearest neighboring trees. We predicted the frequency of conspecifics would be greater than the frequency of heterospecifics around focal trees occupied by each ant species. Our data confirmed this prediction, with the relationship strongest in *Crematogaster sp.* The source of ant colonies on individual trees is therefore likely to be an established colony on a nearby source tree. Future studies should investigate the possibility that a single colony inhabits many trees.

Key words: ant, colonization, interspecific competition, mutualism

Introduction

The tree species *Acacia collinsii* in the dry tropical forests of Palo Verde National Park, Costa Rica, is host to several species of ants. In this mutualistic relationship, the ants provide defense from herbivores and the trees provide shelter and nourishment to the ants via Beltian bodies and extra-floral nectaries (Janzen 1983). Previous research has explored the aggressiveness of acacia-ant species (Balser et al. 1992, Ginsburg et al. 1995), as well as the effectiveness of different species in defending the acacia trees (Bansak et al. 1993). However, the role of local colonization dynamics in producing stand-scale patterns of co-occurrence among these ant species has not yet been addressed.

Using tree size as a surrogate for age, we hypothesized that the ant species occupying the largest tree in a stand influences the colonization of younger neighboring trees. We therefore predicted a positive association between the ant species on the focal tree and the ant species on neighboring trees. Support for our prediction would imply that colonization of neighboring trees is not random, and may be dependent on local colonization dynamics between older source trees and younger neighboring ones.

Methods

We conducted our study in the dry tropical forest approximately 3 km E of the OTS field station, Palo Verde National Park, Costa Rica. We haphazardly selected 20 *A. collinsii* focal trees, 3 cm diameter or greater and larger than its four nearest neighbors, 10 of which were occupied by *P. spinicola* and 10 by *Crematogaster sp.* The mean diameter at knee height (dkh) of all focal trees was 7.90 cm (± 2.08 SD). We then recorded the ant species (*Pseudomyrmex spinicola* or *Crematogaster sp.*) on the four nearest neighbors of each focal tree. Neighboring trees under the focal tree canopy were excluded from the nearest neighbor population as a means of eliminating cases in which the same ant colony inhabited multiple trees (Janzen 1983). Some of the sampled neighboring trees, however, were located within the clearings around the focal trees. Mean distance between the focal tree and the closest neighboring tree was 1.13 m (± 0.40 SD). We used Chi-square goodness of fit analysis to determine the effect of focal tree ant species on nearest neighbor ant frequencies. Expected frequencies were calculated based on nearest neighbor frequencies pooled across focal tree ant species.

Results

There was a significant relationship between the ant species of the focal tree and the frequency of ant species on the nearest neighbors (Fig. 1). Specifically, nearest neighbors were more likely to be occupied by conspecifics of the focal tree ant species than by heterospecifics. This relationship was stronger for *Crematogaster sp.*, with 75% of its nearest neighbors occupied by conspecifics, compared to 60% for *P. spinicola* .

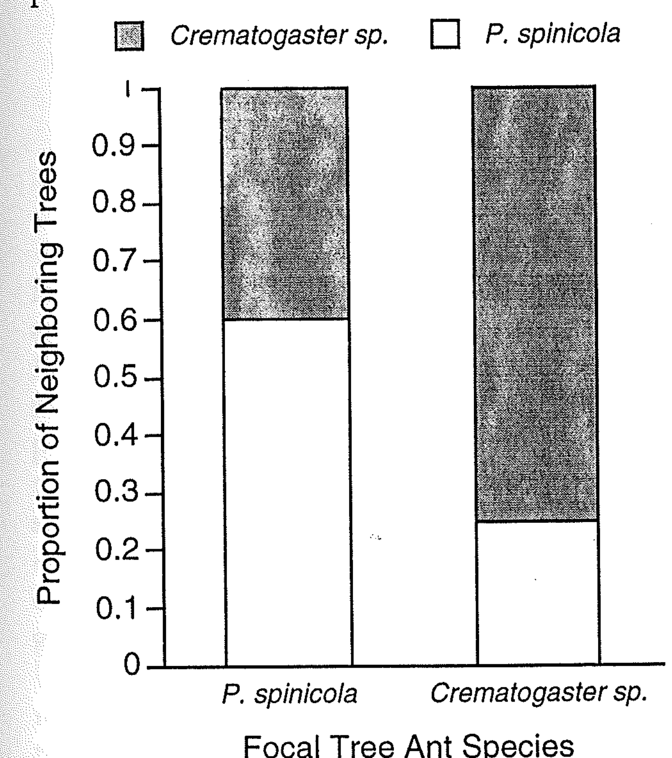

Fig. 1. Proportion of nearest neighbor acacia trees occupied by *Pseudomyrmex spinicola* and *Crematogaster sp.* in relation to the ant species on focal tree (X^2 test, df = 1, p = 0.002).

Discussion

The strong pattern of conspecific aggregation in acacia-ant species that we documented may be a result of four factors. First, clumping of conspecific ants may be due to local dispersal of queens. A new colony begins when a new queen flies from the canopy to search for an unoccupied acacia thorn in which to lay her eggs (Janzen 1983). Given this model of colonization, it is likely that nearby acacias will be occupied by the same species of ant that occupies the larger nearby focal trees.

Second, the distribution pattern we found could result from the ants we sampled on neighboring trees being members of the same colony as the focal tree. At multiple sample sites during our sampling we observed ants travelling on the ground between focal and neighboring trees. Also, Janzen (1983) observed that trees located within the cleared area around a focal tree may be occupied by the same colony. Future studies could concentrate on determining the breadth of the focal colony, as this may be important in determining the local distribution patterns of these ant species within acacia stands.

Third, habitat conditions of an acacia stand may render it more or less suitable for the different ant species. For example, *P. belti* ants appear to prefer trees in areas more open to the sun, while *P. nigrocincta* prefer those trees found in deep shade (Janzen 1983). This pattern suggests that the thermal or light regime of a site may favor occupancy by a particular species. Therefore, local clusters of ant species may be due to species-specific physiological requirements.

Finally, conspecific stands may be a result of competitive interactions among ant species mediated by the location of the focal tree. For example, a source population in a focal tree may actively exclude colonies of other ant species from neighboring trees. The stronger pattern of conspecific aggregation of *Crematogaster sp.* may indicate that this species is a more effective competitor than *P. spinicola*, supporting Janzen's (1983) observation that *Crematogaster sp.* colonies often resist invasion by larger ant-acacia species.

This study has provided insight into stand-scale patterns of ant distribution in the ant-acacia system. The aggregative pattern of ant species distribution among acacia trees suggests that each species may be spatially limited in its ability to create new colonies. Further research might explore the possible range of dispersal for these ant species.

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